South Sinai Growth Charts of Children and Adolescents

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Abstract: Data from a cross-sectional study of 5245 healthy children in South Sinai were used to construct standard growth charts of weight, stature and BMI for each sex. The sample was collected during the project funded by the SSRDP which belong to the European Union commission (project 238). Weight and stature were obtained under standard conditions for each year cohort for children aged 1–16 years, BMI was calculated. The values were compared with those of the Egyptian and WHO growth curves. The constructed growth standards are suitable for growth monitoring programmes throughout South Sinai. [Journal of American Science. 2010;6(10):232-240]. (SSN: 1545-1003).

Keywords: South Sinai Growth Charts; Children; Adolescents

1. Introduction

Somatic growth is an indicator of a child's health and nutrition. For this reason, updated reference growth charts describing the auxological characteristics of the population which his or her patients belong to are particularly useful to the paediatrician [1]. In Egypt, paediatricians can compare growth with local National Egyptian Growth Curves [2]. International curves of WHO are also available [3].

South Sinai is an arid area located at north east region of Egypt. Population have environmental, climatic, social and ethnic specifications that are markedly different from other areas in Nile valley [4]. However, reference values for weight, stature and BMI of these children do not exist. The presence of local standard growth curves will allow comparing growth pattern in S. Sinai with other Egyptian children and will help clinicians for proper evaluation of growth and nutrition status of children in this remote area.

The aim of this study is to present standard age- and gender- specific smoothed percentile curves of weight, stature and BMI for normal healthy South Sinai children and adolescents and compare it to the National Standards of the Egyptian Growth curve [2] and WHO growth charts [3].

2. Subjects and Methods

This piece of work was mediated through the project "Improvement of health and nutrition status of children living at South Sinai". It is funded by the SSRDP which belong to the EU (project 238). Consent was taken by every child caretaker according to regulations of National Research Centre ethical committee.

Sample

A cross sectional study was designed, random stratified sample was calculated according to standard statistical equation [5], and selected to represent all social, environmental and ethnic variations in South Sinai. It included 5245 healthy subjects (2716 boys and 2529 girls), they represent about 12% of all children of the same age based on a sample representing all areas of South Sinai (from 6 areas: El-Tur, Abu Redeis, Abu Zenima, Saint Katherine, Noweibaa and Ras Seder). Age was accurately calculated from birth certificate or from the school files. They were grouped by age (year $\pm$ 6 months) from the age of 1 year until the age of 16 years for each sex separately.

Data collection

The co-investigators in the project were professional physicians, well-trained in anthropometry. They provided training and participated in the data collection. Each team received 20 hours of classroom instructions over a 10-day period, which was followed by practical training for 4 hours per day for 2 weeks. The accuracy of the team measurements was evaluated during the training and during the field study by their respective supervisors. Quality control was accomplished on teams sequentially withdrawn from the field for re-evaluation. Intra-observer and inter-observer differences were periodically checked during fieldwork.

For each child in the sample, the following were performed:

1. Questionnaire to parents, including personal data, socioeconomic data and the medical history of the child with special emphasis on chronic disease or long-term systemic treatment.
2. Complete clinical examination to exclude organic or genetic disorders that might interfere with normal growth.
3. Measurements included body weight; using Seca scale approximated to the nearest 0.01 Kg with

minimal clothes for which no correction was made, and stature; using an infantometer for children 3 years; or body height without shoes using Holtain Stadiometer for children >3 years, and approximated to the nearest 0.1 cm. All measurements were attempted following the recommendations of the International Biological Program [6], using standardized equipments and were recorded as the mean of three accepted consecutive readings.

4. Body mass index (BMI) was calculated as:
  [Body weight (Kg)/height or length (m²)]

Statistical analysis

Means and standard deviation (SD) of body weight, stature and BMI were calculated for each age and sex separately. The independent *t*-test was used in assessment of sex differences. The data points at 3rd, 5th, 15th, 25th, 50th, 75th, 85th, 95th and 97th percentiles were determined for each age and sex, and graphically smoothed using a polynomial fitting equation. Comparison of the current data from South Sinai with the corresponding revised Egyptian Growth Curve [2] and WHO growth charts [3] were performed. The Statistical Package of Social Science "SPSS/PC" software version 9.05 Program was used. P value of less than 0.05 was considered statistically significant.

3. Results
South Sinai values

Means and SD of the weight, stature and body mass index values for South Sinai boys and girls aged from 1 to 16 years of age are presented in tables 1-3 for each sex separately. The means were higher for boys than girls during the first 8 years of age with significance only at ages; 1 to 3 years for weight, 1 to 5 years for BMI and only for age 3 years in height ($P < 0.05$). After that, girls have higher values than boys at ages 9 to 13 for height and 9 to 14 for weight, with significance only at age 11 for height and 11 and 12 for weight. Then, boys become heavier and taller than girls again, with significance only at age 17 for weight and ages 14 to 18 for height. Regarding BMI, girls have the higher values from age 9 to 18 years, with significance at ages 11, 12, 14, 15 and 16 years.

The smoothed percentiles of the weight, stature and BMI values for South Sinai boys and girls aged from 1 to 16 years are presented in Figures 1 to 3 respectively.

National comparison:

Comparison of the 50th percentiles of the BMI of the current South Sinai study and the Egyptian growth curve [2] (2 to 16 years of age), are presented in figure (4) for boys and girls respectively. For both sexes, the 50th percentile of the South Sinai reveals lower values of BMI than the Egyptian Growth curve [2], which reflect that the

South Sinai children have smaller size than the national standards.

International comparison

Comparison of the 50th percentiles of the BMI of the current South Sinai study and the WHO Growth curves (2 to 5 years only) [2], are presented in figure (5a, b) for boys and girls respectively. Boys of the South Sinai Study have higher values of the BMI than the WHO Growth curves [2]. While the girls have the higher values in the second and third years of age only . After that, the girls of the WHO standards have the higher values during the fourth and fifth years of age.

4. Discussion:
The growth supervision of children using growth curves is a widespread and useful tool in general paediatric practice [7] .

In the current survey, we present the South Sinai cross-sectional growth charts for weight, stature and BMI drawn on the basis of a sample of over 5245 healthy subjects (2716 boys and 2529 girls) aged 1-16 years from 6 areas in South Sinai. Standard growth charts are described to represent growth of all children, including those who are not living under favorable conditions [2].

The present data was collected in a cross-sectional study, a practical study design found widely acceptable to statisticians, as it is of high quality and quantity [8, 9, 10]. In addition, the body weight and stature measurements were recorded by well trained and experienced professionals using standard and reliable equipments. Some specific features have been included in the development of this updated reference values. The reference values are given not only for the measurement values, but also for the age-interpolated values and smoothed values. As children are rarely measured at exactly the same age in any growth study, this age interpolation and smoothing was felt to be necessary. The smoothed reference values are better than the measured reference values and were therefore selected in the current study. References are presented in terms of centiles, since the classic reference charts can easily be interpreted by parents as well as by health personnel. This study provided the first standard growth curves of body weight, stature and BMI for South Sinai children and adolescents aged 1-16 years. The sample was ideally representing all areas in South Sinai.

Progressive increase in weight, stature and BMI values appeared in all age intervals with different rates for both boys and girls. Boys

Table (1): Means and standard deviations of Weight (Kg) of Egyptian boys and girls in South Sinai

Age	Boys (2716)			Girls (2529)			P–value
	N	Mean (Kg)	(SD)	N	Mean (Kg)	(SD)	
1 years	135	9.45	2.19	126	8.89	2.06	0.034*
2 years	96	12.15	2.53	76	11.14	1.97	0.004**
3 years	131	13.98	2.60	119	13.05	2.18	0.002**
4 years	146	15.29	2.27	106	15.21	3.06	0.800
5 years	121	17.60	2.92	130	17.25	3.02	0.351
6 years	215	19.98	3.63	180	19.54	3.57	0.224
7 years	250	22.05	3.24	244	21.89	4.47	0.653
8 years	265	24.33	4.44	216	24.07	5.07	0.545
9 years	210	27.02	6.17	246	27.26	6.21	0.687
10 years	230	30.53	7.25	240	30.73	7.67	0.769
11 years	177	32.41	7.29	229	34.87	8.21	0.002**
12 years	203	36.72	7.84	143	40.87	10.21	0.000**
13 years	147	42.73	13.10	106	44.60	12.41	0.252
14 years	120	49.33	13.97	118	49.85	11.37	0.752
15 years	124	53.40	11.36	102	52.09	8.89	0.341
16 years	146	58.81	12.81	148	55.97	10.90	0.041*

*$P < 0.05$=Significant difference. .   ** $P < 0.001$= Highly significant difference.

Table (2): Means and standard deviations of stature (cm) of Egyptian boys and girls in South Sinai
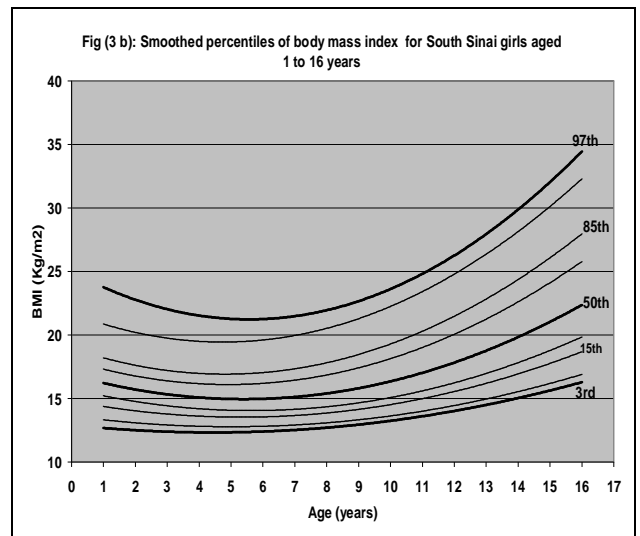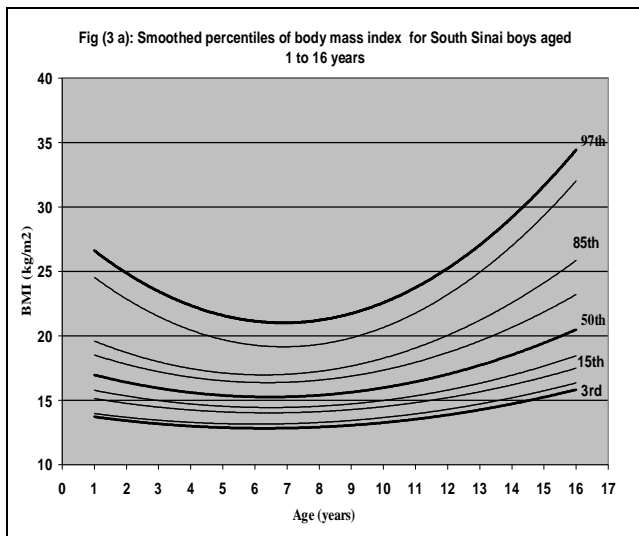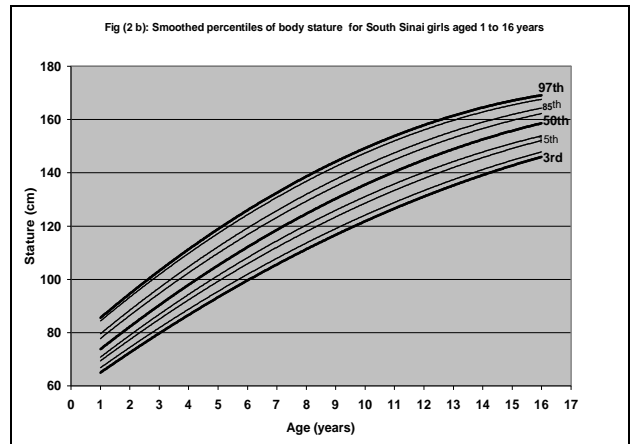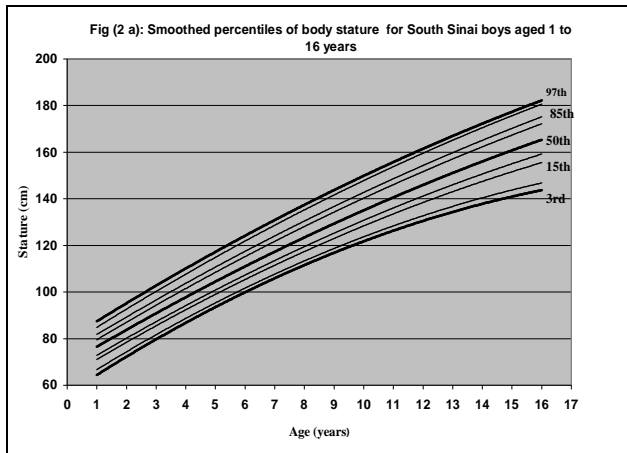
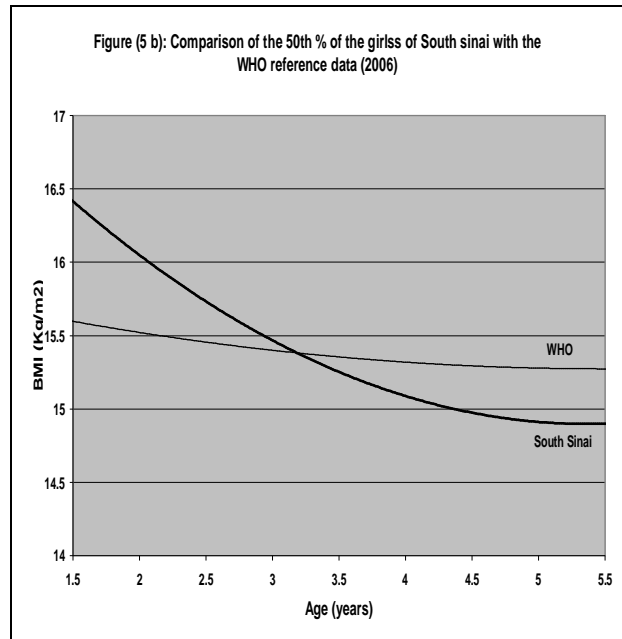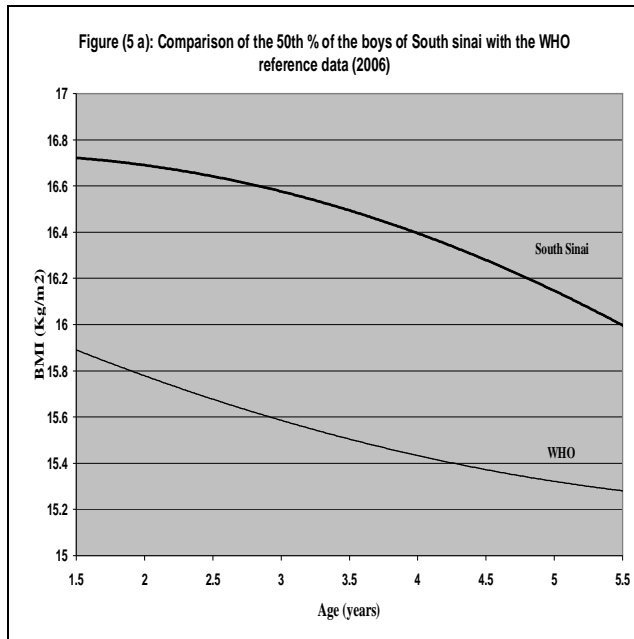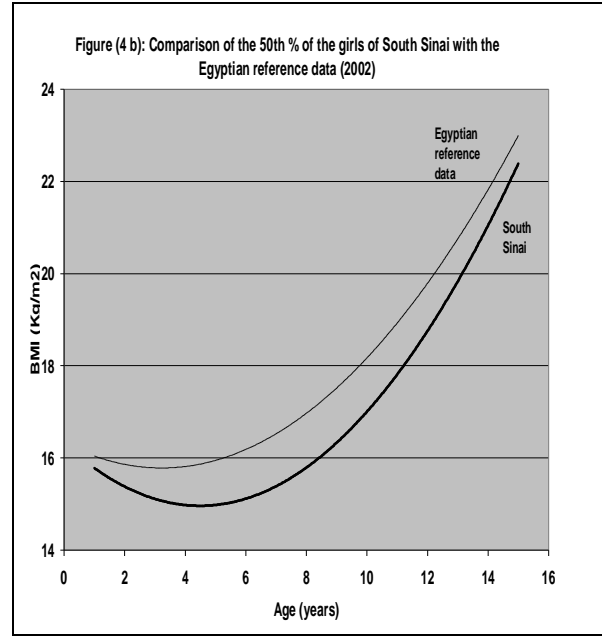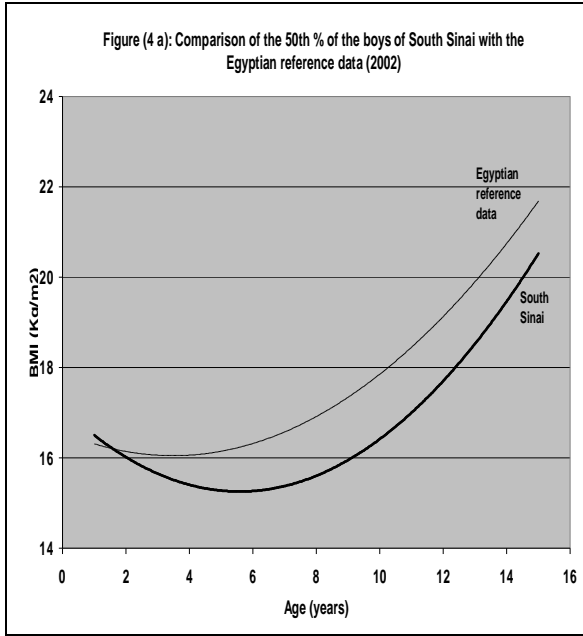| Age	Boys (2716)			Girls (2529)			P–value
	N	Mean (Kg)	SD	N	Mean (Kg)	SD	
1 years	135	73.75	5.79	126	73.45	5.62	0.673
2 years	96	85.03	4.73	76	83.26	6.07	0.033*
3 years	131	90.10	4.92	119	90.15	5.40	0.942
4 years	146	98.02	6.57	106	99.36	6.25	0.104
5 years	121	106.71	7.09	130	107.06	6.31	0.677
6 years	215	113.92	6.63	180	112.89	6.19	0.114
7 years	250	119.15	5.92	244	118.85	6.54	0.584
8 years	265	124.35	6.15	216	123.80	7.47	0.373
9 years	210	129.31	6.63	246	129.48	6.57	0.778
10 years	230	134.72	7.44	240	134.85	7.06	0.850
11 years	177	138.14	7.17	229	139.77	7.29	0.025*
12 years	203	144.05	7.20	143	145.66	8.25	0.054
13 years	147	149.61	9.53	106	149.96	6.90	0.747
14 years	120	157.58	9.83	118	152.86	7.37	0.000**
15 years	124	161.81	8.53	102	155.35	4.32	0.000**
16 years	146	166.25	9.40	148	157.43	6.77	0.000**

*$P < 0.05$= Significant difference. .   ** $P < 0.001$= Highly significant difference.

Table (3): Means and standard deviations of BMI (Kg/ m²) of Egyptian boys and girls in South Sinai

Age	Boys (2716)			Girls (2529)			*P*–value
	N	Mean (Kg)	SD	N	Mean (Kg)	SD	
1 years	135	17.46	3.38	126	16.50	2.83	0.014*
2 years	96	16.82	2.63	76	16.05	2.24	0.046*
3 years	131	17.23	3.17	119	16.10	2.43	0.002
4 years	146	15.87	1.80	106	15.34	2.21	0.038*
5 years	121	15.42	1.75	130	14.97	1.56	0.031*
6 years	215	15.32	1.57	180	15.26	1.70	0.698
7 years	250	15.46	1.34	244	15.40	2.13	0.712
8 years	265	15.64	1.87	216	15.59	2.11	0.785
9 years	210	16.04	2.55	246	16.17	2.75	0.599
10 years	230	16.70	3.05	240	16.79	3.50	0.776
11 years	177	16.85	2.81	229	17.67	2.96	0.005*
12 years	203	17.59	3.02	143	19.16	4.36	0.000**
13 years	147	18.83	4.10	106	19.71	4.57	0.108
14 years	120	19.60	4.47	118	21.26	4.36	0.004*
15 years	124	20.31	3.68	102	21.58	3.52	0.009*
16 years	146	21.23	4.25	148	22.62	4.46	0.007*

*$P < 0.05$= Significant difference.   **$P < 0.001$= Highly significant difference

Fig (1 a): Smoothed percentiles of body weight for South Sinai boys aged 1 to 16 years

Fɪɢ (1b): Smoothed percentiles of body weight for South Sinai girls aged 1 to 16 years

Fig (2 a): Smoothed percentiles of body stature for South Sinai boys aged 1 to 16 years

Fig (2 b): Smoothed percentiles of body stature for South Sinai girls aged 1 to 16 years

Fig (3 a): Smoothed percentiles of body mass index for South Sinai boys aged 1 to 16 years

Fig (3 b): Smoothed percentiles of body mass index for South Sinai girls aged 1 to 16 years

Figure (4 a): Comparison of the 50th % of the boys of South Sinai with the Egyptian reference data (2002)

Figure (4 b): Comparison of the 50th % of the girls of South Sinai with the Egyptian reference data (2002)

Figure (5 a): Comparison of the 50th % of the boys of South sinai with the WHO reference data (2006)

Figure (5 b): Comparison of the 50th % of the girlss of South sinai with the WHO reference data (2006)

recorded higher values over girls during the first 8 years of age with significance only during first 3 years for weight, 5 years for BMI and only at age of 3 years in height. After that, girls have higher values than boys at ages 9 to 13 for height and 9 to 14 for weight, with significance only at age 11 for height and 11 and 12 for weight. This can be explained by earlier puberity and growth spurt of girls [11]. Then, boys become heavier and taller than girls again, with significance only at age 16 for weight and ages 14 to

16 for height. Regarding BMI, girls have the higher values from age 9 to 16 years, with significance at ages 11, 12, 14, 15 and 16 years.

Among the indirect measurements of adiposity, such as skinfold thickness or waist/ hip ratio [12], BMI is largely used to assess weight excess during the whole life, since it applies not only to adults [13] but also to children [14]. These should be carefully monitored, since overweight children are at higher risk of becoming overweight adults

and suffering, as adults, from metabolic and cardiovascular diseases. So, in this study, BMI data allowed us to estimate the current auxological differences between the South Sinai children and adolescents and the national standards of Egyptian growth curve [2], where for both sexes South Sinai children and adolescents have smaller size. This comes in accordance with the objectives of other studies in Qatar [15], Germany [16], London [17], West Indies [11] , Gabon [18], and in Mexico [19]. Also, Boys of the South Sinai Study have biggest size than the WHO Growth curves [2] during the first 6 years of life, while the girls have biggest size in the second and third years of age only. After that, the girls of the WHO standards have the higher values during the fourth and fifth years of age. We cannot say whether the differences are due to differences in genetics, environment, socioeconomic conditions, diet or lifestyle, since all these differences are known to exist.But wide differences in diet and physical activity could be the reason [20].

The large difference in BMI centile suggests that National Egyptian and WHO norms are not suitable for the South Sinai population. The differences between the charts in use and South Sinai charts are expected to result in different estimates of the prevalence of subjects labeled as short stature or overweight or obese: this fact should be clearly explained to South Sinai clinicians when they will begin to adopt South Sinai charts.

South Sinai standard curves intend to supply paediatricians with a tool that avoids the use of charts that are outdated or that refer to other populations, and thus should be suitable for monitoring adequately the growth of their children.

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